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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/783,384	02/15/2001	Ching-Cheng Huang	MEG01-002	2323

28112 7590 07/15/2003

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EXAMINER

LEE, HSIEN MING

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 07/15/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/783,384

Applicant(s)

HUANG ET AL.

Examiner

Hsien-Ming Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 04 March 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-27,32,33,36,39 and 40 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-27,32,33,36,39 and 40 is/are rejected.
- 7) ☒ Claim(s) 20 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

### DETAILED ACTION

1. Applicant's cancellation to claims 37 and 38 is acknowledged.
2. Claims 1-27, 32, 33, 36, 39 and 40 are pending in the application.
3. The objection to drawings and specification, double patenting rejection to claims 15-23, 37 and 38 are withdrawn in response to applicant's amendment filed 3/4/03.
4. The indication of allowable subject matter as set forth in the previous Office action is withdrawn.

### *Specification*

5. The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). Correction of the following is required: all claimed steps related to "**stencil technique**" as recited in claim **24** and claimed steps related to "**screen printing**" as recited in claim **25** lack written description. For example, "evaporation of UBM and solder by applying stencil technique, comprising the steps of patterning and etching a stencil with holes ...", "aligning said stencil with ..", "...using said stencil as a mask" and "removing said stencil form said aligned position."

### *Claim Objections*

6. Claim 20 is objected to because of the following informalities: at line 7-8, "larger diameter that said first diameter" should be – larger diameter **than** said first diameter --. (Emphasis added ). Appropriate correction is required.

### *Claim Rejections - 35 USC § 102*

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

8. Claims 15-19 and 22 are rejected under 35 U.S.C. 102(e) as being anticipated by Lin (US 6,426,556).

In re claims 15 and 22, Lin, in Figs.9-11 and related text on col. 13 (claim 10), expressly teaches the claimed method for forming a metal bump on a semiconductor substrate, comprising the steps of:

- providing a semiconductor substrate 10, said semiconductor substrate 10 having been provided on the surface thereof with a contact pad 24 (*aluminum*), said contact pad 24 overlying a layer of dielectric 29, said layer of dielectric 29 having been deposited over said semiconductor substrate 10 (Fig.9); and
- partially removing said contact pad 24 *in accordance with a mask 37 of passivation material* ( Fig. 10), said removing having a removal thickness and removal surface area 36 (Fig.11).

In re claim 16, Lin teaches that said removal surface area of said contact pad 24 is smaller than a surface area of said contact pad 24 by an amount as shown in Fig. 9.

In re claim 17, Lin teaches that said removal thickness (i.e. 28) of said contact pad 24 is less than a height of said contact pad 24 by an amount as shown in Fig. 10.

In re claim 18, Lin teaches that said removal thickness of said contact pad 24 equals a height of said contact pad 24 as shown in Fig.11.

In re claim 19, Lin further teaches the steps of:

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- depositing a layer of passivation material 37, creating an opening 31 in said layer of passivation material 37 having a first diameter (i.e. the diameter of the opening 31), partially exposing the surface of said contact pad 24 over a surface area of said first diameter, said first diameter of said opening 31 created in said layer of passivation material 37 being smaller than a surface area of said contact pad 24 (i.e. the top surface of the contact pad 24) by an amount (Fig.10); and
- etching said contact pad 24, using said patterned layer of passivation material 37 as a mask, creating an opening 36 in said contact pad 24 having a second diameter, partially first removing said contact pad 24 from above the surface of said layer of dielectric 29 (Fig.11), said second diameter of said opening 36 created in said contact pad 24 being equal to said first diameter of said opening 31 created in said layer of passivation material 37.

***Claim Rejections - 35 USC § 103***

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claims 1-14, 20, 21, 23, 26, 27, 32, 33 and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lin (US'556) in view of Chiang (US 2002/0086520), applicants' admitted prior art ("AAPA") and Mistry et al. (US 6,077,726).

In re claims 1, 2, 3, 4, 9, 20 and 33, Lin, in Figs.9-11 and related text on col. 13 (claim 10), expressly teaches the claimed method for forming a metal bump on a semiconductor substrate, comprising the steps of:

- providing a semiconductor substrate 10, said semiconductor substrate 10 having been provided on the surface thereof with a contact pad 24 (*aluminum*), said contact pad 24 sitting on an underlying layer of dielectric 29 and being electrical contact with at least one point of electrical contact on the surface of the substrate 10 (Fig.9);
- depositing a layer of passivation material 37 over the surface of the layer of dielectric 29 underlying the contact pad 24, including the surface of the contact pad 24 (Fig.10);
- patterning and etching the layer of passivation 37, creating an opening 31 in said layer of passivation material 37 having a first diameter (i.e. the diameter of the opening 31), partially exposing the surface of said contact pad 24 over a surface area of said first diameter, said first diameter of said opening 31 created in said layer of passivation material 37 being smaller than a surface area of said contact pad 24 (i.e. the top surface of the contact pad 24) by an amount (Fig.10);
- etching said contact pad 24, using said patterned layer of passivation material 37 as a mask, partially first removing said contact pad 24 from above the surface of said layer of dielectric 29 (Fig.11), creating an opening 36 in said contact pad 24 having a diameter being about equal to said first diameter of said opening 31 and the opening 36 has a depth that is equal to a height of the contact pad 24;
- depositing a layer of UBM 33 over the surface of a layer of passivation 32, including the opening created in the contact pad 24 (Fig.12);

- depositing and patterning a layer of photoresist 39, creating an opening 38 in the layer of photoresist 39 with larger dimension than the first diameter (Fig. 13);
- electroplating a layer of bump metal 35 in the photoresist opening 38 (Fig. 14);
- stripping the layer of photoresist 39 and etching the layer of UBM 33, using the layer of bump metal 35 as a mask (Fig. 15); and
- reflowing the surface of the layer of bump metal 35, forming the metal bump 35 (col. 11, lines 12-16).

In contrast, Lin does not expressly teach sputtering the layer of UBM 33. However, sputtering has been widely used for forming the layer of UBM, as evidenced by Chiang, in which UBM 340 is formed by sputtering (Fig. 3 and paragraph [0025]).

Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to form the layer of UBM of Lin by sputtering as taught by Chiang since sputtering is a good candidate for forming the UBM.

In re claims 5, 12, 21, 23 and 36, Lin in view of Chiang teach that the layer of UBM comprises a plurality of sub-layers 34 and 35 of different metallic composition, i.e. electroplating an enhanced layer of UBM 34 (copper or nickel), after creating the opening in the layer of photoresist 39, and prior to the electroplating of the layer of bump metal 35 (solder or gold) (Fig. 14 and col. 10, lines 46-52).

In re claims 8 and 32, Lin in view of Chiang substantially teach the claimed method, as stated above, but does not teach depositing *a layer of polyimide* over the surface of the layer of passivation; patterning and etching the layer of polyimide, creating an opening in the layer of

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polyimide having a second diameter being smaller than that of the first diameter of the opening created in the layer of passivation.

However, Mistry et al., in an analogous art of forming UBM, teach depositing a layer of polyimide 16 over the surface of the layer of passivation 14; patterning and etching the layer of polyimide 16, creating an opening in the layer of polyimide 16 having a second diameter being smaller than that of the first diameter of the opening created in the layer of passivation 14 by an amount of  $d$  (Fig. 1).

Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to deposit the layer of polyimide over the layer of passivation as taught by Mistry et al. in the method of Lin in view of Chiang, prior to forming the UBM, since by doing so it would protect the underlying layers from corrosion and improve reliability (col.3, lines 14-18, Mistry et al.)

In re claims 10 and 11, Lin in view of Chiang and Mistry teach that the contact pad 24 comprises aluminum and the opening 36 created in the contact pad 24 has a depth that is equal to a height of the contact pad 24 (Fig. 11, Lin).

In re claims 6, 7, 13, 14, 26 and 27, Lin substantially teaches the claimed method as stated above except that said contact pad is accessed by means of interconnect metal being provided in a plane of said contact pad; and overlying said layer of dielectric and said contact pad is accessed by means of at least one via provided through said layer of dielectric.

However, AAPA, in an analogous art, teaches contact pad 17' is accessed by means of interconnect metal 23' being provided in a plane of said contact pad and overlying said layer of



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dielectric 25' and said contact pad 17' is accessed by means of at least one via 21'/27' provided through said layer of dielectric (Figs. 20b, 20d and related text on page 26).

Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to form the interconnect metal and the via as taught by AAPA in conjunction with Lin's method of forming the metal bump since by doing so it would provide a channel for establishing electrical contact between the contact pad and surrounding electrical components (page 27, first paragraph of the instant specification).

11. Claims 24, 25, 39 and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lin (US'556) in view of Kung et al. (US 6,197,613).

In re claims 24 and 39, Lin does not teach utilize forming the UBM by stencil technique.

In re claims 25 and 40, Lin does not teach utilize forming the UBM by screen-printing technique.

However, Kung et al. teach utilizing stencil technique and screen-printing for forming the UBM (col.4, lines 63-67, col. 8, lines 19-21 and col. 10, claim 4).

Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to form the UBM of Lin by stencil technique or screen-printing as taught by Kung et al. since these techniques are cost effective methods for forming the UBM.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 703-305-7341. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 703-306-2794. The fax phone numbers for the

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organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Hsien-Ming Lee  
Examiner  
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July 9, 2003